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Final Report

X-Ray Temporal and Spectral Studies of Blazars with the Ginga Satellite

for NASA Grant: NAG8-697

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This is the final report to the National Aeronautics and Space Administration (NASA) concerning NASA grant NAG8-697. This grant was awarded to Dr. C. Megan Urry of the Space Telescope Science Institute in response to a proposal, entitled "X-Ray Temporal and Spectral Studies of Blazars with the Ginga Satellite", to collaborate with Japanese colleagues in using the Ginga X-ray satellite. The grant was originally awarded on 2/27/88 and expired on 3/31/94.

The Ginga X-ray satellite had unprecedented sensitivity in the 2-20 keV energy band, allowing us to make detailed temporal and spectral studies of a large number of blazars, which are a kind of unusually luminous and variable active galactic nuclei. We were successful with several proposals and were able to observe a number of different active galactic nuclei.

Our investigations under this grant fall broadly into two categories: (1) Ginga observations of blazars, usually in conjunction with simultaneous multiwavelength observations using other facilities, and (2) the application of calculated pair plasma spectra to the X-ray colors of active galactic nuclei. These are described in turn.

1 X-Ray Studies and Multiwavelength Monitoring of Blazars

We had Ginga observations of the blazars Mrk421, H0323+022, PKS2155-304, OJ287, and Mrk501. The latter two were of low quality and have not led to substantial results. The observations of Mrk421 were part of an extensive multiwavelength campaign, for

which preliminary results were reported by Marlowe et al. (1992). A large paper is in draft form and should be completed within the coming year, as time permits.

The Ginga observations of H0323+022 have been published by Kohmura et al. (1994). The Ginga observations of PKS2155-304 appeared in a number of places, most notably Sembay et al. (1993). Copies of this latter paper are attached to this report.

Details of this work can be found in the cited publications.

2 Pair Plasmas and X-Ray Spectral Diagnostics

To help pursue my studies of the X-ray spectra of AGN, I hired a post-doctoral fellow, Dr. Paola Grandi, who worked at STScI from October 1992 through October 1993. During this time, she developed a technique for evaluating X-ray spectra in terms of pair-reflection models. These models combine the output X-ray spectra from complex pair-plasma calculations with reflection from cold material, to produce synthetic hard X-ray spectra. Dr. Grandi then converted these to X-ray colors appropriate to specific X-ray detectors (e.g., Exosat, Ginga, etc.). Our first step in this work was to apply her calculations to Exosat data (Grandi et al. 1994); we are now applying this work to Ginga data. Details can be found in the cited publications.

3 Bibliography

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